# HIGH-SENSITIVITY FRANCK-CONDON FACTOR MEASUREMENTS ENABLED BY OPTICAL CYCLING

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Recent experiments have successfully laser cooled a variety of molecules, including diatomic, linear triatomic, and symmetric top species [1-3]. Laser cooling and trapping can require repeatedly scattering more than 10,000 photons per molecule, so all potential losses above the level of 1 part in $10^5$ must be identified and repumped to mitigate losses. Here, we report on the use of optical cycling to measure vibrational branching ratios of laser-coolable polyatomic molecules. We achieve relative intensity sensitivities at the $10^{-5}$ level, approximately a factor of 100 more sensitive than previous dispersed fluorescence studies [4-6]. The apparatus described can be adapted to probe any molecule with a nearly-closed cycling transition by tuning two laser wavelengths. In addition, we discuss how these high-precision branching ratio measurements have allowed us to infer values for Renner-Teller parameters in CaOH and YbOH, and for pseudo-Jahn-Teller parameters in $CaOCH_3$.

[1] J. Barry, et al., Nature 512, 286 (2014).
[2] I. Kozyryev, et al., Phys. Rev. Lett. 118, 173201 (2017).
[3] D. Mitra, N. B. Vilas, et al., Science 369, 1366 (2020).
[4] I. Kozyryev, et al., New J. Phys. 21, 052002 (2019).
[5] A. C. Paul, et al., J. Chem. Phys. 151, 134303 (2019).
[6] E. T. Mengesha, et al., J. Phys. Chem. A 124, 3135 (2020).